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ABSTRACT

This paper presents the eight major categories of recommendations made by the National Council of Teachers of Mathematics' (NCTM's) booklet "An Agenda for Action," that are considered components of programs designed to improve mathematics education, and as a by-product, raise mathematics scores of pupils on standardized tests. The three major and urgent problems that must be addressed are: (1) School mathematics programs are generally not keeping pace with the changing needs for mathematical ability dictated by changing technologies; (2) Most students are not studying sufficient high school mathematics to prepare them for their futures as workers, consumers, or citizens; and (3) There is a growing shortage of qualified mathematics teachers in the secondary classroom. The NCTM offers the professional organization's resources, efforts, and commitment to the solution of the problems addressed, and has provided a blueprint to begin. The actual solutions depend upon the actions of the public. (MP)

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Iris M. Carl Clinic A-14 "THESE PROGRAMS WORKED IN RAISING MATH SCORES."

Dr. Strasheim, Dr. Love, members of the National School Boards Association, and guests:

May I express the thanks of the National Council of Teachers of Mathematics for the invitation to be a presentor at this Clinic. I am personally privileged as a new member of the Council's Board of Directors to have been selected to represent the organization at this most august convention.

The National Council of Teachers of Mathematics (NCTM) welcomes the opportunity to speak to a topic that has received national attention, The Council would be derelict of its duty if our presentation consisted of a recitation of a listing of specific programs that have resulted in increased test scores in mathematics. To outline specifics of exemplar programs responsibly is best reported by those actually involved in their design and implementation. The Wilmette Public Schools superintendent, Dr. Love, has excellently provided you with such meaningful evidence. The NCTM is obligated by virtue of its national position to share with you the benefit of research, studies, and surveys in the field of mathematics, the basic commonality of structure of successful programs. Our collective responsibility is awesome. Never has it been clearer than when we confront this bit of elementary arithmetic -- the child of age ten will be at a productive peak in, say, twenty years. In twenty years we will have turned not a decade, but a millenium. It will be the year 2000. Therefore, this blueprint is for now and the future.

The National Council of Teachers of Mathematics data are unique in two ways. The Council did seek out through a survey funded by the National Science Foundation , Priorities in School Mathematics, the opinions, preferences and priorities of many groups. The populations sampled were elementary teachers, secondary mathematics teachers, two year college mathematics teachers, mathematics supervisors, mathematicians, teacher educators, principals, school board members and parents.

This extensive survey assumes an important and useful role. It is important here, however, to recognize that opinion surveys, in and of themselves, do not and should not generate professional recommendations. Although public opinion is responsibly listened to, the role of the "technical expert," the professional who, by virtue of training, experience, and commitment is uniquely qualified to give knowledgeable advice, is crucial. Society has the right to expect this considered advice, this leadership. Indeed, informed decision cannot be made without it.

The NCTM data are probably unique in another way. They rest on the extensive base about current practices in mathematics instruction. The Council probably knows more about the specifics of classroom mathematics teaching and learning than we or any other professional educational body ever have. In this sense, the data are based on realism. Much of this information comes from a series of status studies funded by the National Science Foundation and from the timely and significant message gleaned from the results of the Second Mathematics Assessment of the National Assessment of Educational Progress. You may recall from the extensive coverage of those results released in the fall of '79 that, put in simplest terms, students demonstrated a satisfactory level of compu-

tational ability with whole numbers, but results on items where such skill was to be applied to the solution of problems were dismal. These data are not the thinking of just one or two committees. They benefited greatly from input from NCTM standing committees, from data voluntarily gathered by the Association of State Supervisors of Mathematics, from a heartening response from our affiliated groups, and from opinions communicated by individual members. There have been some important precursors during the latter half of the decade of the seventies, amont them are the report of the Conference Board of the Mathematical Sciences National Advisory Committee on Mathematical Education, the Euclid Conference of the National Institute of Education, the report of the College Board Panel on the SAT scores, the Mathematical Association of American's Conference on the Priorities in Mathematics Education, the thoughtful and influential position on basic skills of the National Council of Supervisors of Mathematics, and interpretive reports of the National Science Foundation status studies and the National Assessment of Educational Progress assessment data by NCTM teams,

.We are approaching a crisis stage in school mathematics. Policy makers are not confronting the deepest problems because the public and its representatives have been diverted by a fixation on test scores.

.There are at least three major and urgent problems that must be addressed:

1. School mathematics programs are generally not keeping pace with the changing needs for mathematical ability dictated by developing technologies.
2. Most students are not studying sufficient high school mathematics to prepare them for their futures as workers, consumers, or citizens.
3. There is a growing shortage of qualified mathematics teachers in secondary school classrooms.

I will not go through all the specific recommendations that should be considered components of programs designed improve mathematics education and as a by-product raise mathe scores, The booklet, An Agenda for Action, will be available for you to read in all its detail. I will

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present the eight major categories of recommendations and some of the specific actions recommended.

Recommendation 1 will surprise no one, perhaps; it is

PROBLEM SOLVING MUST BE THE FOCUS OF SCHOOL MATHEMATICS IN THE 1980's

This means that the ultimate goal in our teaching is the ability to use and apply the mathematics learned. This is not a new goal, of course. But as the national assessment has shown, we are not doing as well as we should in attaining it.

There are two myths that, because they are fallacious, hinder the attainment of that goal. One is the fallacy that if one has gained mastery of skills, one can hen necessarily apply them later. The second, and a related fallacy, is that you must have mastery levels of skills before you can be presented any challenging mathematical problems. One of the pernicious consequences of the second fallacy is the limiting of remedial programs to just more the the same -- drill, drill, drill. Such mechanistic objectives can lead to the kind of mind-set, the obsession with familiar routines, habits, and formulas, that is, in fact, counterproductive to the development of problem-solving ability. We need to prepare people who are comfortable with choices therefore, we should be preparing our students to approach the unfamiliar. Although the Agenda, in looking ahead a decade, recommends ultimately a reorganization of the curriculum, the immediate need -- the beginning point -- is a change in attitude and classroom environment.

Recommended Action 1.3: Mathematics teachers should create classroom environments in which problem solving can flourish.

Fundamental to the development of problem solving ability is an open-mind -- an attitude of curiosity and exploration, the willingness to proble, to try, to make intelligent guesses. Problem solving, which is essentially a creative acitivity, cannot be built exclusively on routines, recipes, and formulas.

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The Council cannot now exactly what abilities will be in most demand in the twenty-first century, but we are confident there will be little demand for human imitations of a ten-dollar calculator. From all the sources used to gather these data, problem solving ability was the number one priority.

Recommentation 2 is

> THE CONCEPT OF BASIC SKILLS IN MATHEMATICS MUST ENCOMPASS MORE THAN COMPUTATIONAL FACILITY.

The battle is still being waged against an excessive narrowing of the curriculum in the name of "back to basics." There must be an acceptance of the full spectrum of the basic skills and a recognition that there is a wide variety of such skills beyond the mere computational to design a basic skills component of the curriculum that enhances rather than undermines education.

The time and energy that teachers and programs should be devoting to building beyond minimal foundations are sometimes skirted, being considered risky deviations from the minimal targets on which educators believe they will be judged. Such actions place a low ceiling on mathematics competence -- at the onset of an era when our lives will be more deeply permeated by multiple and diverse uses of mathematics than ever before. It is dangerous to assume that skills from one era will suffice for another. Skills are tools. Their importance rests in the needs of the times.

Some recommended actions are: 2.1: The full scope of what is basic should contain at least the ten areas identified by the National Council of Supervisors of Mathematics. 2.2: The identification of basic skills in mathematics is a dynamic process and should be continually updated to reflect new and changing needs. 2.3: Changes in the priorities and emphases in the instructional program should be made in order to reflect the expanded concept of basic skills.

Recommendation 3 is

MATHEMATICS PROGRAMS MUST TAKE FULL ADVANTAGE OF THE POWER OF CALCULATORS AND COMPUTERS AT ALL GRADE LEVELS.

Students must obtain a working knowledge of how to use computers and calculators, including the ways in which one communicates with each and commands their services in problem solving.

Some recommended actions are: 3.2: The use of electronic tools such as calculators and computers should be integrated into the core mathematics curriculum. 3.4: A computer literacy course, familiarizing the student with the role and impact of the computer, should be a part of the general education of every student. 3:12: Certification standards for teachers should include preparation in computer literacy and the instructional uses of calculators and computers. Support for the use of calculators was mixed and varied in degree according to the different populations sampled with highest support from supervisors and teacher educators. There seems to be lurking in these results the residual fear that calculators will be a crutch, supplanting the learning of computational skills altogether.

The position of the NCTM has always been very clear on this and the data are supportive of that published position. They state: "It is recognized that a significant portion of instruction in the early grades must be devoted to the direct acquisition of number concepts and skills without the use of calculators. However, when the burden of lengthy computations outweighs the educational contribution of the process, the calculator should be readily available."

The fourth recommendation relates to and is implied by, the first thress. It states:

STRINGENT STANDARDS OF BOTH EFFECTIVENESS AND EFFICIENCY MUST BE APPLIED TO THE TEACHING OF MATHEMATICS.

Instructional time is a precious commodity. It must be spent wisely. Teachers should apportion instructional time according to the productive importance of the topic, recognizing that the value of a skill or knowledge is subject to change over time. There are certain algorithmic skills that require a great expenditure of classroom time. Curriculum developers should examine whether the calculator has so greatly reduced the demand for these pencil-and-paper techniques that such time could be more effectively apportioned.

Some recommended actions are: 4.1: The major emphasis on problem solving in the curriculum must be accommodated by a reprogramming of the use of time in the classroom. 4.2: School administrators and parents must support the teacher's efforts to engage students more effectively in learning tasks.

The issue of testing has been in the forefront of media attention for several years. To much of the public, test scores appear to be at once the symptom of problems and the promise of salvation. This limited view of the evaluation of programs, students and even the institution of the school itself is in many ways a self-fulfilling prophecy. Superficial crash programs responding to pressure to increase scores can in fact seriously damage educational qaulity.

Test scores alone should not be considered synonymous with achievement or program quality. A danger is the increasing tendency on the part of the public to assume that the sole objective of schooling is a high test score. This is often assumed without the critical knowledge of what is being tested or whether test items fit desired goals.

Recommendation 5 is

> THE SUCCESS OF MATHEMATICS PROGRAMS AND STUDENT LEARNING MUST BE EVALUATED BY A WIDER RANGE OF MEASURES THAN CONVENYIONAL TESTING.

Some recommended actions are: 5.4: The evaluation of mathematics pro-

grams should be based on the program's goals, using evaluation strategies consistent with these goals.

If problem solving in mathematics is to be a major objective, then evaluation must respond to this goal. The evaluation of problem-solving performance will demand new approaches, innovative techniques. Certainly present tests are not adequate.

5.1: The evaluation of mathematics learning should include the full range of program goals, including skills, problem solving, and problem-solving processes. Minimal competencies should not be construed as an adequate measure of an individual's mathematics achievement.

5.2: Parents should be regularly and adequately informed and involved in the evaluation process.

The next recommendation is the most challenging to the mathematics community. What it proposes will be difficult for the schools, but the present situation is untenable. Considering the increasing advantages of mathematical knowledge in everyone's life, most students are opting out of mathematical study too early.

Interestingly, public polls show that recognition that mathamatics is an exxention subject for all students. Yet the subtle message sent to students says otherwise. It is typical to find that only one year of mathematics is required in grades 9 -- 12. Furthermore, many colleges admit students with no more than this minimum. Yet the data show very few college degree programs for which a high school preparation of les than three years is adequate. On what basis do we assume that students are mature enough to elect additional mathematics beyond the minimal requirement of one year, yet apparently they are not mature enough to elect, of their own accord, the several years of required English and history. When students discontinue the study of mathematics early in high school, they foreclose many options, not only for college study, but for more and more vocational programs.

Recommendation 6 is

> MORE MATHEMATICS STUDY MUST BE REQUIRED FOR ALL STUDENTS AND A FLEXIBLE CURRICULUM WITH A GREATER RANGE OF OPTIONS SHOULD BE DESIGNED TO ACCOMMODATE THE DIVERSE NEEDS OF THE STUDENT POPULATION.

Some recommended actions are: 6.1: School districts should increase the amount of time students spend in the study of mathematics. At least three years of mathematics should be required in grades 9 through 12. The amount of time allocated to learning mathematics in elementary school should be increased.

6.2: In secondary school, the curriculum should beoome more flexible, permitting a greater number of options for a diversified student population. Increasing required mathematics in high school put a burned on teachers but it obligates them in an exciting, challenging way. The recommendation is for three years of mathematics. But not the same three years for everyone. The traditional college-bound program is not necessarily optimal for everyone's chosen direction, even if they are fully capable. The growing diversification of applications of mathematics, as in the mathematical sciences, demands more than a single college preparatory program. At the same time, techbical and vocational training at different levels demands more and more diverse mathematical background. In an increasingly technological, quantitatively oriented society, every citizen and consumer needs deeper quantitative literacy, computer literacy, and problem-solving skill of the mathematical type as well as marketable skills. Can there be a serious argument that enough mathematics has been learned by the age of fourteen to meet fully even the least of these needs?

6.5: Teachers, school officials, counselors, and parents should encourage a positive attitude toward mathematics and its value to the individual learner. The previous recommendations will not be attainable without a firm base of support from the profession and the public. Thus the last two recommendations address vital issues and problems concerning both pro-

fessionalism and public support. Recommendation 7 says

MATHEMATICS TEACHERS MUST DEMAND OF THEMSELVES AND THEIR COLLEGUES A HIGH LEVEL OF PROFESSIONALISM.

There is growing evidence that we are seeing an erosion of the concept of professionalism. Are school administrators encouraging and supporting professional growth activities as they once did? Teachers and administrators must accept performance and not protectionism as a synonym for professionalism.

Some recommended actions are: 7.1: Every mathematics teacher should accept responsibility for maintaining teaching competence. Full advantage should be taken of all existing opportunities for continuing education. Teachers should belong to professional organizations that are dedicated to the improvement of teaching and learning.

7.2: School boards and school administrators should take all possible means to assure that mathematics programs are staffed by qualified, competent teachers who remain current in their field. The status, compensation and teaching conditions necessary for retention of qualified teachers must be dramatically improved. School administrators should encourage teachers to take an active professional role and should permit them to par ticipate, without penalty, in conferences and vital professional work.

The last recommendation, 8 is.

PUBLIC SUPPORT FOR MATHEMATICS INSTRUCTION MUST BE RAISED TO A LEVEL COMMENSURATE WITH THE IMPORTANCE OF MATHEMATICAL UNDERSTANDING TO INDIVIDUAL AND SOCIETY

At present there are too many obstacles to the effective functioning of teacher and student in a true teaching-learning interaction. There are also too many obstacles faced by school administrations and school boards that go beyond their direct control.

There are deep problems in mathematics education that must be confronted

by the public because they are ultimately the problems of our society a and can only be solved by the cooperation of all sectors of that society. One of the most serious which is growing in magnitude is the shortage of qualified teachers of mathematics. Administrators are forced in an increasing number of classrooms to staff with persons who do not meet qualifications in mathematics preparation. This is not solely a school problem. What we in education need to do is ask the public, "What are you willing to do about it?"

Unfortunately, it is true today that it is more and more difficult to attract people into mathematics teaching and more and more difficult to keep them there. Mathematical knowledge and skill are at a premium in tod today's world, and it is easy for someone with a mathematics bacground to find employment at a considerably higher salary than teaching affords. Lack of public support has also eroded the non-financial rewards that have historically attracted people into teaching.

The National Council of Teachers of Mathematics offers our professional organization's resources, efforts, and commitment to the solution of the problems addressed. We have devised an, Agenda a blueprint to begin. We cannot solve these problems alone. We challenge society at large and educational communities to confront these, their problems. We cannot continue to paper over the difficulties with superficial, short-term remedies.

NCTM has proposed a starting point. We offer our cooperation. But we must now say to the caring public, the representative members of our nations' school boards, actual solutions depend largely on you.